

REPLACEMENT PARAGRAPH: Page 1, lines 11-15

This application is a divisional application serial no. [_____] 09/835,115, [Agents Docket Number ONX-115A,] entitled "MEMS Mirrors With Precision Clamping Mechanism,"
5 filed April 12, 2001, which is based on and claims priority from Provisional Application 60/250,081 filed November 29, 2000.

Version with Markings to Show Changes Made

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A 1 claims priority from Provisional Application 60/250,081 filed November 29, 2000.

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REPLACEMENT PARAGRAPH: Page 5, lines 1-7.

A first embodiment of the invention is shown in Fig. 2A, which shows an apparatus 200A having a movable flap that can be precisely clamped by electrodes on either 0 or 90
20 degrees surfaces. Such a structure allows the flap to be clamped, for example, in either a vertical or horizontal
A 2 position. Such a flap may be used as part of an array of several MEMS mirrors in a planar matrix switch.

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25 A first embodiment of the invention is shown in Fig. 2A, which shows an apparatus [200] 200A having a movable flap that can be precisely clamped by electrodes on either 0 or 90 degrees surfaces. Such a structure allows the flap to
30 be clamped, for example, in either a vertical or horizontal position. Such a flap may be used as part of an array of several MEMS mirrors in a planar matrix switch.

REPLACEMENT PARAGRAPH: Page 10, line 29 to page 11, line 25

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Figs. 4A-4H depict an example of a process for fabricating a structure of the type shown in Fig. 2A, Fig. 2B, Fig. 3A or Fig. 3B. The structure is formed from a starting material wafer 400 having a device layer 403, a substrate layer 401 and an insulator layer 402 disposed between the device and substrate layers as shown in Fig. 4A. The base and/or device layer may be made of a crystalline material. For example, the starting material is typically a silicon-on-insulator (SOI) wafer with a silicon <110> handle substrate as the substrate layer 401; the device layer can be standard silicon of <100> orientation; and the insulating layer can be an oxide formed, e.g., by oxidation of a surface of the substrate layer 401. Alternatively, the starting material may be a silicon-on-nitride wafer or any other suitable type of wafer material known to the art. The device layer 403 may be used, for example to form a mirror plate for a MEMS optical switch, or an array of such switches, such as that shown in Fig. 6. In the first step Fig. 4B, two parallel deep trenches 404 that reach the buried oxide 402 may be formed in the substrate layer 401 from the backside of the wafer 400. The widths of the trenches 404 may be sufficiently narrow that they can be completely filled-in during a later step. The trenches 404 may define the periphery of a cavity 415 that may be formed to accommodate a flap similar to those described above with respect to Figs 2-3B. It is also possible to form a single continuous trench that defines the periphery of the cavity. The trench or trenches 405 may be etched by an anisotropic etchant like KOH with silicon nitride or silicon oxide mask (not shown for simplicity). Alternatively, the trenches 404 may be formed in the substrate layer 401 prior to bonding the device layer 403 to the substrate layer 401.

Figs. 4A-4H depict an example of a process for fabricating a structure of the type shown in Fig. 2A, Fig. 2B, Fig. 3A or Fig. 3B. The structure is formed from a starting material wafer 400 having a device layer 403, a substrate layer 401 and an insulator layer 402 disposed between the device and substrate layers as shown in Fig. 4A. The base and/or device layer may be made of a crystalline material. For example, the starting material is typically a silicon-on-insulator (SOI) wafer with a silicon <110> handle substrate as the substrate layer 401; the device layer can be standard silicon of <100> orientation; and the insulating layer can be an oxide formed, e.g., by oxidation of a surface of the substrate layer 401. Alternatively, the starting material may be a silicon-on-nitride wafer or any other suitable type of wafer material known to the art. The device layer 403 may be used, for example to form a mirror plate for a MEMS optical switch, or an array of such switches, such as that shown in Fig. 6. In the first step Fig. 4B, two parallel deep trenches 404 that reach the buried oxide 402 may be formed in the substrate layer 401 from the backside of the wafer 400. The widths of the trenches 404 may be sufficiently narrow that they can be completely filled-in during a later step. The trenches 404 may define the periphery of a cavity 415 that may be formed to accommodate a flap similar to those described above with respect to Figs 2-3B. It is also possible to form a single continuous trench that defines the periphery of the cavity. The trench or trenches 405 may be etched by an anisotropic etchant like KOH with silicon nitride or silicon oxide mask (not shown for simplicity). Alternatively, the trenches [405] 404 may be formed in the substrate layer 401 prior to bonding the device layer 403 to the substrate layer 401.

REPLACEMENT PARAGRAPH: Page 12, line 27 to page 13, line 3.

Next, a hinged flap 410 may be formed from the top device layer 403 as shown in Fig. 4F. The flap may optionally
5 contain landing pads 408 on its bottom surface to minimize contact area with the base or sidewall and to provide electrical isolation as described above. The flap 410 may
A4 be mechanically connected to the base through a flexure or torsional beam similar to those depicted and described with
10 respect to Fig. 2A, allowing the flap 410 to move out of the plane of the base. A reflecting surface 413 may be formed on the surface of the flap 410 so that the resulting device may function as a mirror.

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20 contain landing pads 408 on its bottom surface to minimize contact area with the base or sidewall and to provide electrical isolation as described above. The flap 410 may be mechanically connected to the base through a flexure or torsional beam similar to those depicted and described with
respect to Fig. 2A, allowing the flap 410 to move out of the plane of the base. A reflecting surface [410] 413 may
25 be formed on the surface of the flap 410 so that the resulting device may function as a mirror.